From these experiments, the results of which were subsequently mapped in relation to the various heat-levels indicated by solar phenomena, I drew the following conclusions in 1879:—

"I think it is not too much to hope that a careful study of such maps, showing the results already obtained, or to be obtained, at varying temperatures, controlled by observations of the conditions under which changes are brought about, will, if we accept the idea that various *dissociations* of the molecules present in the solid are brought about by different stages of heat, and then reverse the process, enable us to determine the mode of evolution by which the molecules vibrating in the atmospheres of the hottest stars *associate* into those of which the solid metal is composed. I put this suggestion forward with the greater confidence, because I see that help can be got from various converging lines of work."

Calcium.

In 1876 I produced evidence that the working hypothesis that the molecular grouping of calcium which gives a spectrum having its principal line at 4226·9 is nearly broken up in the sun, and quite broken up in the spark, explained the facts which are that the low temperature line loses its importance and practically disappears from the spectrum of the sun, in which H and K are by far the strongest lines.[1]

I summed up the facts regarding calcium as follows:[2] "We have the blue line differentiated from H and K by its thinness in the solar spectrum while they are thick, and by its thickness in the arc while they are thin. We have it again differentiated from them by its absence in solar storms in which they are almost universally seen, and, finally, by its absence during eclipses, while the H and K lines have been the brightest seen or photographed."

I afterwards attempted to carry the matter further by photographing the spectra of sun-spots. In all cases H and K lines were seen reversed over the spots, just as Young saw them at Sherman, while the blue calcium line was not reversed.[3] The oldest of these photographs which has been preserved bears the date April 1, 1881.

The experimental results in the case of calcium, therefore, followed suit with those obtained from iron and magnesium, and indicated that the cause of the inversion of intensities in the lines of a substance under different circumstances is due to the varying degrees of dissociation brought about by different temperatures.

Both in the case of iron, magnesium and calcium the high temperature lines involved are not seen at all at lower temperatures, and even in the case of calcium, when photographic exposure of 100 hours' duration have been employed. It should be sufficiently obvious to everybody then that temperature alone is in question.

Finally, then. The similar changes in the spectra of certain elements, changes observed in laboratory, sun and stars are simply and sufficiently explained on the hypothesis of dissociation. If we reject this, so far no other explanation is forthcoming which coordinates and harmonises the results obtained along the different lines of work.

NORMAN LOCKYER.

HIGHER COMMERCIAL EDUCATION AND THE UNIVERSITY OF LONDON.

OUR knowledge of what is needed for the improvement of commercial education has undoubtedly been amplified and better defined by the action of the London Chamber of Commerce and of the Technical Education Board of the London County Council. The important conference held in June last at the Guildhall settled certain points beyond further controversy, and cleared the way for a new departure in those directions in which improvement is practicable and possible. The "Summary of Results" published by the Chamber will serve as a useful guide to educational authorities desirous of adapting school teaching to the requirements of our mercantile classes. The special Committee, appointed in May 1897 by the Technical Education Board, were actively engaged during the greater part of the year 1898 in taking evidence from merchants, bankers, teachers, and organisers of commercial classes, and their valuable report, recently published, gives some interesting extracts from the evidence of the expert witnesses they consulted, together with their own conclusions and recommendations. The report also contains a summary of the notices, previously published in various other reports, of the facilities provided in foreign countries for commercial education of different grades.

For many years there has been a growing feeling in this country, that the mercantile classes are placed at a disadvantage in competition with their foreign neighbours, owing to the absence of any specialised schools of commerce, such as exist in other parts of Europe. The reports of our consuls abroad went to show, that in the distant markets of the world agencies were being established with continental manufacturing firms, and that England was being gradually driven to the wall, in consequence of the greater activity, and the special aptitudes of commercial travellers, representing mercantile firms in Germany, Belgium, and Switzerland. It was also shown, that owing to their special business qualifications and to their knowledge of foreign languages, foreigners were preferentially employed in business houses in this country, and it was generally assumed, that although there might be other causes of an industrial and economic character, which helped this result, the defects of our educational system were mainly responsible for the gradual displacement in many important markets of English wares for those produced in other countries.

It is possible there may have been some exaggeration in the facts on which these conclusions were based; but there is no doubt that a strong *à priori* case for inquiry was established, and the report of the London County Council, and of the conference at the Guildhall, supplemented by further evidence from our consuls, and from other persons who have independently investigated the subject, has shown the extent to which foreign nations have benefited by their special schools, and the directions in which improvements may be looked for in our own methods. A very important item of evidence was furnished by Mr. Powell in his consular report on this subject of November 1898, which has undoubtedly modified the views of some of our educational reformers. Mr. Powell brought into prominence the fact, that the alleged pre-eminence of Germany was in no way due to her commercial schools; but that the movement, now in progress, for developing commercial education had followed, and had not preceded the rapid advance in her industrial operations. The wide publication of this fact has been useful in directing attention to other causes than the absence of special commercial schools in this country, for the explanation of the undoubted ability of German clerks and commercial agents to succeed where Englishmen too often fail. The inquiry instituted last year will serve to prevent the repetition of vague statements about the comparative excellence of commercial schools abroad, and shows the extent of the changes that are needed in our present educational system to give us all the advantages that commerce can be expected to gain from special schools or new methods of instruction.

The recommendations in the report of the London County Council are in general agreement with the conclusions of the conference, and deprecate any attempt to teach the practice of commerce as a part of general education in any of our secondary schools. The language of some of the recommendations in the report of the County Council is perhaps a little misleading, owing to the fact, that where the report speaks of "commercial education," what is really intended is "training adapted to commercial life"; and from the evidence given in the report, and emphasised at the conference, such a training should be general rather than special, and the subjects of instruction should be so taught as to encourage independence of thought and the power of original investigation. It is the habits that such a training affords rather than any special knowledge, beyond that of foreign languages, that have helped the German schoolboy, and cannot fail to prove useful to the future business man. It is important, however, that the education should be of a modern type. Physical science, including geography, mathematics and drawing, English composition and modern languages, should form the principal subjects of instruction in our secondary commercial schools; but the subjects should not be taught with any special view to mercantile practice, but by scientific methods equally applicable to the study of other subjects, and to the instruction of pupils destined for other occupations.

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[1] *Proc. Roy. Soc.*, vol. xxiv. p. 352.
[2] *Ibid.*, vol. xxviii. p. 171.
[3] *Ibid.*, vol. xxxvi. p. 444.

It is recognised that in all schools above the primary, different weight may be given to different branches of study, and that the teaching, even on the modern side, may be differentiated without being specialised. But the basis of such an arrangement should be found in the different amount of time given to the different studies, and not in the introduction of any specialised teaching. For instance, whilst the prevalent system of teaching foreign languages to all classes of pupils is generally recognised as susceptible of improvement, it will be readily admitted that pupils on the commercial side of a school might devote more time to the study than those intended for the medical or engineering professions. It is equally evident that the experimental method of teaching elementary science, as sketched out in the regulations of the Joint Scholarships' Board, are serviceable not only, nor indeed especially, to future technical students, but equally to all boys and girls, whatever the career they may eventually follow. Indeed, recent inquiries at home and abroad have shown the desirability not only of improving our methods of school teaching, but also of introducing system into our school organisation. It is mainly owing to the absence of any distinct aim or purpose in the teaching given in so many of our schools, that the secondary education of this country fails to satisfy the requirements of persons training for different careers, or to afford a fitting preparation for the different branches of industrial life. Suggestions with a view to the organisation needed are contained in the County Council's report; and it is hoped that when the machinery contemplated in the new "Board of Education Bill" shall be completed and in good working order, our secondary education may be sufficiently elastic to adapt itself to the various wants of industrial life. This is evidently what Prof. Hewins refers to when he says: "The most serious difficulty that has to be dealt with in the organisation of commercial education is to be found in the unsatisfactory state of secondary education in England."

One thing, recent inquiries will certainly have shown, viz. that in its higher developments the theory of business is a subject capable of being treated as a branch of higher education; and those who read the reports of the conference and of the Technical Education Board's Committee will find no difficulty, as regards trade, in agreeing with what Emerson wrote nearly sixty years ago: "I look on trade and every mechanical craft as education also."

It is, however, in the University stage of education, if anywhere, that specialisation with a view to a commercial career seems to be justified. The conditions of modern trade and commerce show, that for those who are to direct industrial concerns, and equally for those who are to discharge the important functions of consuls in different parts of the empire, the ordinary education of a good public school, even on the modern side, needs to be followed up by a special training in the theory of commercial science. It is well known that for many years excellent schools of this higher type have flourished in France, Belgium and Italy, and more recently in Switzerland. In Paris there are two institutions, one established by the Chamber of Commerce and another by private enterprise, in which commercial education of university grade is given. These institutions are well attended, the age of the students ranging from sixteen years upwards. It is true that the recognition of these schools by the State, as exempting the students from a part of the obligatory military service, has had an important influence upon the attendance, parents preferring that their sons, destined for a commercial career, should spend two years in a school of commerce than in barrack life. But, apart from this consideration, there is no doubt, that in France and Belgium, the value of a special commercial training for youths over sixteen years of age, before going into business, is fully recognised by merchants and bankers. In Germany, too, the recent establishment of a High School of Commerce in connection with the University of Leipzig, is strong evidence of the importance, which those who may be regarded as the best educational authorities in Europe attach to such specialised teaching.

In London, the great success of the School of Economics, under the direction of Prof. Hewins, has shown that studies connected with the business of commercial life admit of being treated in such a way as to claim recognition as part of a university education. No one can look through the general course of study pursued in that school, in which there are now over four hundred students, without coming to the conclusion, that the aim of the teaching is distinctly educational and scientific, and that the students' work is such as demands the exercise of intelligence and thought, leading up to practice in methods of investigation and research. What was previously regarded as merely possible and advisable, viz. the treatment of economics in relation to the theory of commerce, as a subject of university training, has been proved to be both practicable and useful. By higher commercial education is now understood a system of education "which provides a scientific training in the structure and organisation of modern industry and commerce, and in the general causes and criteria of prosperity, as they are illustrated or explained in the policy and experience of the British Empire and foreign countries." Among the subjects which such a course of education embraces, and in which fresh investigations are encouraged, are the study of statistics with application to the machinery of business, including banking, insurance, the theory of exchange; transport and the means of communication; industrial law, factory and other legislation, and the principles of international law; the history of economics and trade; commercial geography including trade routes; systems of taxation; the study of commodities, &c. The machinery of modern commerce offers any number of applications of the general principles underlying the consideration of such subjects; and what is usually understood by university education is well exemplified in the serious study of the facts, which the careful investigation of the phenomena bearing upon these matters helps to elucidate. It is in this spirit of inquiry that the course of instruction at Leipzig and in London has been arranged; and a glance at the programme of either of these schools will serve as a sufficient reply to those, who are disposed to question the possible connection between the practice of business and the academic training which we associate with university education.

The London School of Economics has had, so far, a very successful career. In its temporary home in Adelphi Terrace are found lecture-rooms and class-rooms, in which a staff of over twenty teachers give instruction; also a well-furnished library containing over 10,000 volumes on economic subjects. The growing importance of the study of economic science in its relation to international trade and commerce, and the success of the attempt to establish in London a special high school for the teaching of the subject will be regarded as justifying the University of London Commissioners in recommending the addition of a faculty of economics to the other faculties of the University; and it may reasonably be hoped that the present school will in the near future be greatly developed, and become more closely associated with the new University.

To many persons it seems highly desirable that the economic and commercial faculty of the new University should be located in the Imperial Institute. The well-arranged collections of Indian and Colonial products, which form a most important part of the equipment of that institute, would be found of especial value in illustrating the teaching of that branch of commercial education known as *Waarenkunde*. Nowhere else in London do similar facilities exist for instruction in the technology of commercial products. Within the building, too, has been provided a chemical laboratory, which is now largely used for the examination and analysis of foreign products; and much of the scientific investigation, therein carried on, under the able direction of Prof. Dunstan, is an essential feature in the programme of a high school of commerce. Indeed, a large part of the work which entered into the original scheme of the promoters of the Imperial Institute, might, it would seem, consistently, and with great advantage to the public, be continued in that institute under the auspices of a school of economics, industry and commerce, in connection with the reconstituted University of London. Whether such an arrangement can be effected is a matter for careful consideration; but there is no doubt that the association with the new University of a school of "economics and political science," under a separate faculty, suggests a reasonable basis of union between the educational side of the Imperial Institute and the future University of London.

As a consequence of the proposed recognition of economics and commerce as a separate faculty of the University, the London County Council have offered, under certain conditions, to allocate to its maintenance a yearly sum of 2500*l*., being part of their promised contribution to the funds of the University. By the aid of such an endowment, increased as it probably will be from other sources, the present School of Economics might enter upon a wider sphere of usefulness with new resources and facilities for advanced teaching, and might become a very important part of a teaching university.

It is now generally understood that a modern university must differ in many essential features from the university of former centuries. Such a university must gather up not only the wisdom stored of ages, but the newest knowledge in its application to the industrial requirements of modern life. The indebtedness of pure science to the investigations and experiments of astronomers, physicians and engineers is generally recognised, and shows how inquiries originally undertaken with a view to some practical end have often led to the discovery of new scientific truths. What is true in physical science is found to be the case also in economic science; and the establishment of a school for inquiry into economic and industrial phenomena; the better definition of our existing knowledge of the subject for the purposes of instruction; the organisation of systematic methods of investigation and research; and, above all, the recognition of the teachers, as constituting a separate university faculty, with common aims and objects, will certainly give a new impulse to the study of the laws of productive industry, and will add largely to our knowledge of the conditions under which trades are fostered, and nations are able to compete with one another in the struggle for new markets.

The establishment of a Faculty of "Economics and Political Science (including commerce and industry)" by no means implies the granting by the University of a corresponding degree. A University degree in any faculty is only supposed to indicate that a student has undergone a systematic course of instruction in a certain department of knowledge, and the precise title of the degree is a matter of comparative indifference. It is essential that, in any new university, there should be distinct and separate avenues to a degree, through the study of the special groups of subjects, in which the student elects to receive his training; and it is enough that the degree should certify that he has undergone such a training. There is no necessary connection between a faculty and a degree. In London, a candidate can take the M.B. or B.S. degree in the Faculty of Medicine, and the M.A. or D.Lit. in the Faculty of Arts. In the Faculty of Science, there are already several different paths along which a student may proceed to graduation, and it is a matter of no great moment whether students in the Faculty of Economics should take the B.Sc. degree, or whether a new title should be invented. Indeed, it may be hoped that, both in engineering and in economics, considerable freedom will be given to the recognised teachers of the university, and that different combinations of subjects, provided they involve an equivalent academic training, will be accepted by the Academic Council of the new university for the degree examination.

The existence in London of a high school of commerce in close connection with the reorganised university, will not only give an impetus to the study of subjects bearing directly upon the development of our manufacturing trades and commerce, but will exercise an important influence upon the curriculum of our secondary and higher grade schools. As the "Board of Education Bill" provides, in the first place, for the organisation of the central authority and of the Consultative Committee, and leaves to a later date the constitution of local authorities, so it will be found that, if a commercial school of university rank is successfully established, the first step will be made towards the organisation of a system of commercial education for schools of a lower grade.

The proposal of the Statutory Commissioners to establish a Faculty of Economics and Political Science in connection with the new university, is the opening of a new era for commercial education in this country; and the recommendation will be welcomed, as showing that the Commissioners fully recognise the importance of bringing the new University of London into close relation with the varied educational requirements of the present day.

PHILIP MAGNUS.

WILLIAM RUTHERFORD.

THIS distinguished physiologist was a son of the border. He was born at Ancrum in Roxburghshire in 1839, and he died in Edinburgh on February 21, 1899. About thirty-six years of his busy life, from the date of his graduation in 1863, were spent in the pursuit of physiological science. After studying at Berlin, Vienna, and Paris, he became assistant to the late John Hughes Bennett, who then filled the chair of Physiology in Edinburgh. For many years Bennett had taught histology and the use of the microscope to voluntary classes, and among his pupils may be mentioned the well-known